oldest. Some of the volcanoes are younger, and a considerable number of smaller cones may have been built within a few thousands of years. C. E. DUTTON.

COMETS II AND III OF 1884.

IT is quite remarkable, that, of the five comets visible during the year 1884, four should have been periodic, and two of these of short period, and observed apparently for the first time at this return. By short period is generally understood a period of somewhere in the neighborhood of five years, of which we have well-known examples in the comets of Encke (3.3 years), Brorsen (5.5 years), Winnecke (5.7 years), Faye (7.4 years), etc., — twelve in all.

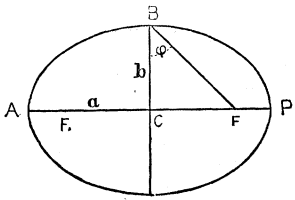

FIG. 1.

The new comets referred to are comets II and III of 1884, — the first discovered by E. E. Barnard of Nashville, Tenn.; and the second, by Max Wolf, a student at Heidelberg. Neither of these comets has been a conspicuous object, — not even visible to the naked eye, I believe, — but they are fair representatives of the class known as 'telescopic' comets.

As I have intimated, the orbit of comet 1884 II (Barnard), is elliptical with a period of about five and a half years. Making allowance for necessary uncertainty, the elements show a certain resemblance to those of DeVico's 'lost comet,' 1844 I, which, though certainly elliptical, has not been seen since, if we except a single rather doubtful observation made at Paris in 1855. The period agrees very well with that determined for DeVico's comet by Brünnow (5.469 years); but Berberich has pointed out that their identity cannot be assumed, for the time elapsed since 1884, forty years, does not correspond to any whole number of revolutions. He notes, also, that the physical appearance would seem to be against this identity; DeVico's comet, in a similar position with respect to the earth, having been visible to the naked eye. Leverrier thought it very probable that this comet of DeVico's was identical with one observed in 1678 by La Hire; and Laugier and Mauvais concluded that it was identical with the comets 1585, 1766 II, and 1819 III or IV.

Below are the elements of the two comets, brought together for comparison. DeVico's comet was computed by Brünnow; Barnard's, by Frisby.

Comet 1884 II (Barnard).

T	= 1884, Aug. 16.2895, Greenwich M. T.	
π	= 306° 10′ 9″.4	Mean equinox, 1884.0.
Ω	= 5° 23′ 51″.2	
ω	= 300° 46′ 18″.2	
i	= 5° 24′ 48″.7	
ϕ	= 34° 51′ 49″.3	
log a	= 0.474164.	
μ	= 689″.858.	
Period	= 1878.65 days.	

Comet 1844 I (DeVico).

T	= 1844, Sept. 2.511238, Berlin M. T.	
π	= 342° 30′ 49″.6	Mean equinox, 1844, Sept. 0.
Ω	= 63° 49′ 0″.1	
i	= 2° 54′ 50″.3	
ϕ	= 38° 8′ 42″.0	
log q	= 0.0742308.	
μ	= 649″.1503.	
Period	= 1996.46 days.	
Motion direct.		

Let me try to show how these elements represent the orbit of a comet, and to give an idea of the shape of this orbit, and its position in space with respect to the sun and earth. By far the most satisfactory way of doing this would be to construct from the elements a cardboard model, which I think can be done with little difficulty from the following directions.

We know, that, in obedience to the law of gravitation, comets must move about the sun in some form of conic section, — the ellipse, parabola, or hyperbola. As a matter of fact, for the majority of comets, the orbit is given as a parabola; a few are known to be elliptic; but it cannot be said with certainty that any are hyperbolic.[1]

We are first to fix the shape and dimensions of the curve, and then its situation with reference to the plane of the ecliptic, in which the earth moves.

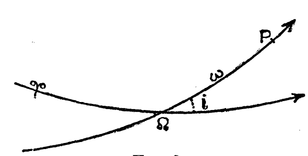

FIG. 2.

Suppose, for a moment, that the orbit is an ellipse, the sun being at one focus (F, fig.1). Two of the 'elements' determine the form of the ellipse: —

1. The semi-major axis CP, which is denoted by the letter a.

2. The eccentricity e, the ratio of the distance from the centre to the focus, to the semi-major axis; that is,

$$e = \frac{CF}{CP}.$$

[1] Newcomb's 'Popular astronomy.'

For the ellipse the eccentricity is always greater than 0, and less than 1; and, the nearer it is to 1, the more elongated is the ellipse.

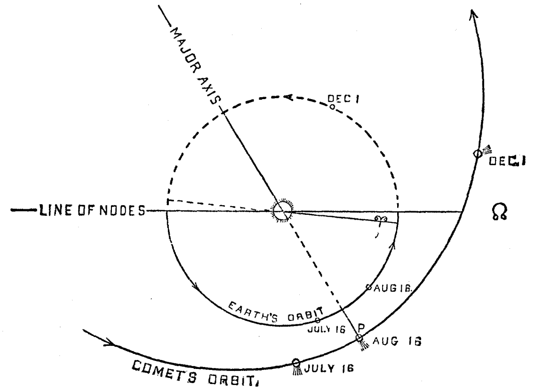

FIG. 3.—ORBIT OF BARNARD'S COMET.

Instead of e, the 'eccentric angle' ϕ, or *CBF* in the figure, is sometimes given; but from it we can obtain e by means of the relation

$$e = \sin \phi.$$

I might say that the linear distances a and e are usually expressed as decimal parts of the earth's mean distance from the sun. If $a =$ 2.98 (as in the case of Barnard's comet), it means that the mean distance of the comet, or the semi-major axis of the orbit, is 2.98 times that of the earth, or about two hundred and seventy-six million miles. So, generally, measurements expressed in this way are reduced to miles by multiplying by ninety-two and a half million.

Having settled the shape of the orbit, we must determine its position in space. For this purpose three more elements are required:—

3. The longitude of the ascending node, the angular distance from the first point of Aries (♈, fig. 2) to the point in which the comet pierces the plane of the ecliptic in passing from the southern to the northern side. It is usually denoted by the symbol ☊. The opposite or descending node is denoted by the symbol ☋.

4. The inclination, i, of the plane of the comet's orbit to that of the ecliptic.

5. The longitude of perihelion, π, which in fig. 2 is the arc ♈☊ + ☊P, or

$$\pi = \Omega + \omega.$$

6. Finally, we must state where the comet is in its orbit at some specified time. For comets we generally give the date of perihelion passage, *T*.

To these six elements there might be added the mean daily motion, μ, expressed in seconds of arc; and the period of revolution, sometimes called U, in days or years.

With the semi-axes a and b given (b is obtained from a and ϕ by means of the formula, $b = a \cos \phi$), the curve is constructed to any scale we please. I have found it convenient to use a scale of two inches. The earth's orbit is then represented with sufficient

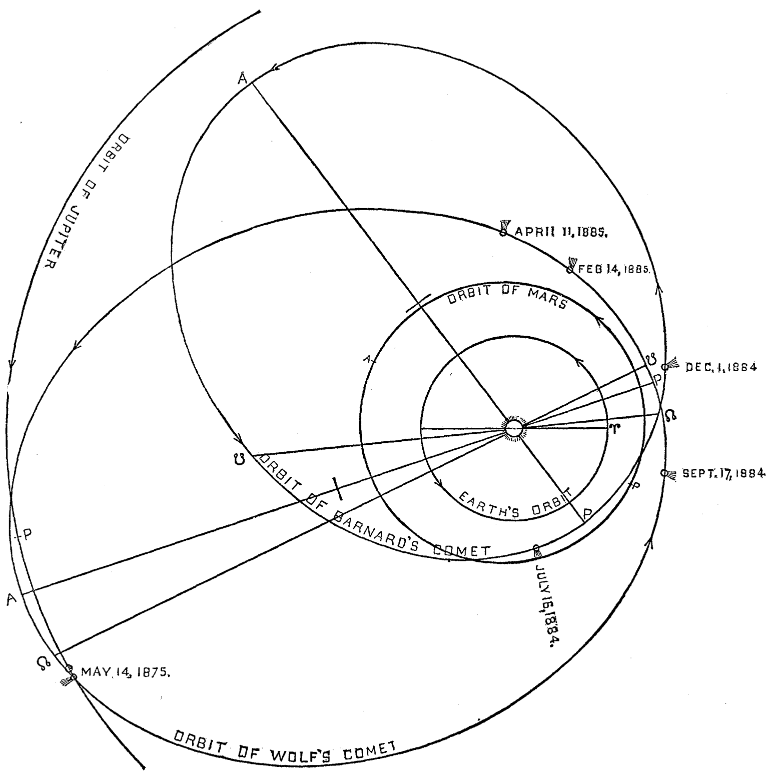

FIG. 4.—ORBITS OF COMETS 1884 II AND III.

accuracy by a circle with a radius of two inches; and on the circumference we mark the vernal equinox (♈, fig. 3), — a zero point from which longitudes are to be measured. We count in the direction opposite to the hands of a watch, which is also the direction in which the earth moves. We mark also the 'line of nodes' (fig. 3), — the line in which the two planes intersect, making the angle ☊ with the line of the equinoxes.

is 'retrograde,' they will be moving in opposite quadrants. The centre of our circle, and the focus of our ellipse, are, of course, made to coincide.

For a parabolic orbit, the construction of a model is not materially altered, though there is this important difference between a parabola and an ellipse. The parabola is an 'open' curve, and, the farther we recede from the sun at the focus, the farther apart do the branches

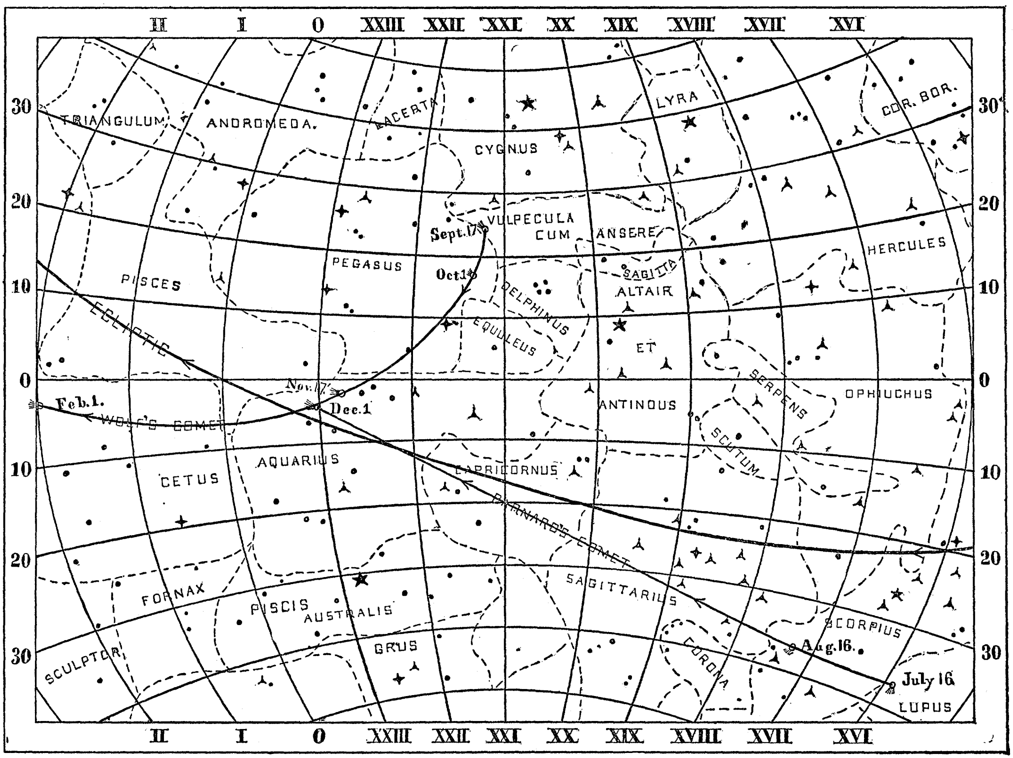

FIG. 5.—APPARENT PATHS OF COMETS 1884 II AND III.

The next thing we want to know is how the major axis of the comet's orbit is pointing. This is determined by supposing that P and ☊ (fig. 2) at first coincide, and then that P is moved till $P☊ = \omega$ (in fig. 3 this angle is 300° 46′, so that the acute angle ☊⊙P is 59° 14′). The planes are inclined at the angle i (not shown in fig. 3, but given in fig. 2); and it only remains to fasten the two pieces of cardboard in this position, cutting a slit in either one, so that they will fit together. If the comet's motion is 'direct,' the comet and earth will be moving in the same quadrant, as they move away from the node. If its motion

become; and consequently a comet moving in such an orbit, will, if undisturbed, 'double' the sun, and then go off forever on its journey through space.

For the parabola, the elements are given in a little different form. The eccentricity is equal to 1. The major axis stretches out to infinity, and we give in its place the perihelion distance q, and the distance from the focus to the vertex of the curve PF (fig. 1). But five elements are then necessary to represent the parabola.

Collecting these symbols for reference, they are as follows: —

T = time of perihelion passage.
π = longitude of perihelion.
$\omega = \pi - \Omega$.
Ω = longitude of the ascending node.
i = inclination of orbit.
e = eccentricity = $\sin \phi$.
ϕ = eccentric angle.
a = semi-major axis, or mean distance.
q = perihelion distance.
μ = mean daily motion.
U = period of revolution.

The equinox to which the elements are referred is given, since the vernal equinox is continually shifting on account of the slow motion of precession.

With what has gone before, I think that very little need be said in explanation of fig. 3, which is drawn from a model made as I have just described. The true form of a portion of the comet's orbit is given, and upon it is projected the earth's orbit, which, with such a small value of i, appears here again as a circle. The positions of the earth and comet are given for several dates.

Fig. 4 shows the entire orbit of Barnard's comet (as well as that of Wolf's comet, presently to be mentioned), the earth's orbit, that of Mars, and a small portion of the orbit of Jupiter. These orbits are all represented in one plane, and on so small a scale the inclinations are not great enough to cause any appreciable distortion. For the comets, the lines of nodes and the major axes are drawn in. Perihelion in all of the orbits is marked *P;* aphelion, *A*.

Fig. 5 is a map of a portion of the heavens showing the apparent path of the comet among the stars during the period of its visibility. It was in the constellation Lupus when first seen, and moved towards the north and east, through the constellations Scorpius, Sagittarius, Capricornus, and Aquarius. The place of the comet is given here, also, for July 16, the date of discovery; Aug. 16, perihelion passage; and Dec. 1, the limit of visibility.

COMET 1884 III (WOLF). — Wolf's comet, an insignificant object physically, is moving in an orbit of unusual interest. Its period is about six and three-fourths years. The entire orbit is shown in fig. 4, where two of the most interesting peculiarities are brought out, — a near approach to Jupiter in longitude 209°, May, 1875 (about eight million miles); and a near approach, at the descending node of the comet, to the orbit of Mars. From both of these planets the comet is evidently liable to considerable perturbation, and its past and future history become matters of some uncertainty.

Our chart shows a large part of the comet's apparent path in the heavens during its visibility. WILLIAM C. WINLOCK.

GEOGRAPHICAL NOTES.

THE roll of geographical journals is increased by one. The Florentine section of the Italian African society has been authorized by the central council and treasurer to issue a bulletin, the first two fasciculi of which appeared recently. It is intended to be partly eclectic, presenting geographical and especially African news to its readers, and partly the official record of the proceedings of the section. The present number contains an address by Professor Licata on the *rôle* of Italy in the Red Sea, an article by A. Mori on Massowah, and other matters of the same sort; bibliography, including a notice of a number of papers on the zoölogy of Africa, which have appeared from time to time in the annals of the civic museum of natural history in Genoa; African notes; the proceedings of the society; and the annual address of Vice-president Stefanelli on the operations of the section for 1884. The new journal is free to members, or may be subscribed for at the secretary's office, Via San Gallo No. 33, Florence, at the rate of five lire per annum.

Dr. Sériziat has been for two years engaged in collecting Lepidoptera at Collo, in the more wooded district of Algeria, reaching some thirty-five hundred feet above the sea. He has obtained about a hundred and eighty-four species in all, — about as many as are ascribed to the whole of Algeria in the most recent catalogue. There are about fifty-two diurnal species, — just half as many as are found at Basle in Switzerland. The cause of this deficiency is stated to be the small number of succulent plants suitable for the food of larvae, and the incredible multitude of insectivorous birds. It would be a source of gratification if Collo would lend to America her surplus of the latter in place of our own inecffiient wild birds; and our climate would, perhaps, be quite well suited to the Algerian birds, at least in certain regions.

On the occasion of the presentation to the Russian representative, of the gold Vega medal recently awarded by the geographical society of Stockholm to Prjevalski, Mr. Elfwing, the American consul, made an address on behalf of the society, which was much appreciated, and which has been reproduced in the 'Revue géographique' of Renaud. Mr. de Berends made a suitable response on behalf of the absent explorer. This is the third award of the medal, the previous recipients being Baron Nordenskiöld and Capt. Palander.

The death of Madam Carlo-Serena, author of geographical articles on the Caucasus, is announced as having occurred in 1884 at an obscure village — Oedips — in Greece, on the borders of the Aegean. She was chiefly noted for her passion for mountain travel, and the courage and energy with which she